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The Recording of Monophasic Action Potentials Simultaneously from both the Epicardial and Endocardial Surfaces of Porcine Hearts

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Background: Monophasic Action Potentials (MAPs) are electrical signals that represent the focal depolarizations and repolarizations of cardiac myocytes. The detection of MAPs via applied catheters may aid in determining both characteristic waveforms as well as the relative viability of the underlying cardiac tissue. For example, such detection would be beneficial in cases of atrial fibrillation, where ablative therapies are used to kill the cells triggering the arrhythmia. By recording MAPs at the trigger site post-ablation, the success of the treatment can be assessed immediately, and corrected if necessary. The purpose of the present study was to collect and compare signature endocardial and epicardial MAPs from isolated swine hearts.

Methods: Hearts from swine were re-animated using previously described Visible Heart® methodologies: each heart was functioning in a normal sinus rhythm. Modified 7 Fr mapping catheters, with 4 ball electrodes and 2 ring electrodes each, were placed upon the epicardial surface while another was inserted into the heart. The catheters were arranged such that both recorded from the same approximate anatomical location. This was verified through internal imaging with an endoscope and an overhead camera (and in some cases fluoroscopy). Endocardial and epicardial MAPs, along with the ECG, were recorded using a multichannel recorder.

Results: MAPs were recorded from both atrial and ventricular locations on the right side of the heart. Preliminary results show that the profile of MAPs when recorded in the right atria differ for epicardial and endocardial sites. When comparing recordings taken in the right ventricle however, the profile of epicardial and endocardial MAPs were nearly identical.

Conclusions: In cases of atrial fibrillation an ablation may be performed either epicardially or endocardially on the myocardium: attempting to make induced lesions transmural. The detection of Monophasic Action Potentials using a MAPs catheter can be used to determine the relative, acute, viability of cardiac tissue in a specific area, which can lead to a higher rate of success for the treatment of atrial fibrillation.

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Self-expandable MRI Enhancing Peripheral Stent

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Background: MRI guided vascular intervention and follow up imaging has advantages over X-ray-imaging, such as no ionizing radiation, no iodinated contrast agent and good soft tissue contrast. The use of MRI during angioplasty and for imaging of the vascular stents is still challenging due to the artefacts caused by the devices made of metal (shielding of the stent lumen). To improve the imaging of the stent an MRI enhancing stent was developed.

Methods: Self-expandable MRI enhancing stent (8 mm x 40 mm) was made of Nitinol. The resonant circuits that were used to enhance the MRI signal were completely integrated into the design of the device. This stent, adjusted to the 1.5T MRI (Signa, GE, Waukesha, Wisconsin, USA) was crimped into a self-made delivery catheter (14F) and released in a phantom box and in a vascular phantom filled with 0.9% NaCl solution under MRI guidance. GE sequences such as gradient echo and real time were used with parameters: TR of 34 ms, TE of 2 ms and FA between 15° and 45°.

Results: MRI was successfully used as guidance for the delivery of the MRI signal enhancing stent. The delivery was repeated 3 times in a phantom box and 3 times in the vascular phantom. The signal enhancement in the lumen of the stent was observed each time after the complete expansion of the device.

Conclusions: The visualization of the stent lumen can be improved by using the MRI signal enhancing stents. This technology allows to overcome artefacts of the stent and can bring the MRI guided vascular procedures such as angioplasty and imaging of the vascular devices one step closer.

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Treatment of Porcine Aneurysm Models with The Multilayer Flow Modulator

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Background: The Multilayer Flow Modulator (MFM) (Cardiatis, Isnes, Belgium) is a new concept in intra-arterial hemodynamic disruptive technology, and used to treat vascular aneurysms. The aim of this study is to examine with porcine test animals whether the MFM can successfully treat abdominal aortic aneurysms (AAA) through intra-arterial hemodynamic modulation without substantial parent or small branch artery compromise.

Methods: The MFM was evaluated in 8 porcine test animals with AAA experimentally induced by grafted venous tissue. The planned study period was 1 month, at which point all animals were to be euthanized and explanted for final examination of devices and vessels. The MFM delivery system underwent a separate evaluation with planned deployment of 8 devices in 1 pig without an induced aneurysm.

Results: In the delivery system evaluation, navigation, placement, deployment, and withdrawal were without complication. In the evaluation of MFM performance in induced aneurysms, angiographic follow-up at 8 days showed 3 aneurysms reduced in size and 1 totally excluded. Collective examination upon final angiography and explantation showed an overall trend of reduction in aneurysm size. In 2 explants, the aneurysm opening was nearly occluded with thrombus and the venous graft wall had thickened significantly, suggesting an evolution into an arterial type vessel wall. No intimal hyperplasia was observed in any of the explants. The visceral arteries covered by the device remained patent, and the device was found to be adhering to the arterial wall with endothelialization clearly visible.

Conclusions: In this in vivo study, the MFM was implanted without intra-arterial compromise and aneurysms were stabilized over the course of the study, while adequate blood flow was preserved to collateral arteries. Further studies are needed to assess the MFM.

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Feasibility Of Carotid Artery Placement Of The Novel Impella Pediatric Prototype

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Background: Options for pediatric circulatory support are limited and highly invasive. A novel assist device is being developed based on the current Impella 2.5 (Danvers, MA) to provide less invasive support for children with heart failure. Limitation for placement of most devices is related to femoral vessel size. In small children, carotid artery (CA) diameter exceeds the femoral artery. This study was performed to determine feasibility and technique for Impella Pediatric catheter insertion via the CA of small pigs similar in size to our target human population.

Methods: A total of 10 implants were performed. In all animals, right common carotid artery (RCCA) cut down was performed to expose the vessel. Two dimensional ultrasound measurements of the RCCA were obtained prior to cut down. Two underwent direct insertion. Eight underwent insertion via chimney graft, 4 short (5 cm) and 4 long (12 cm). All grafts were 6 mm in diameter. The pigs were supported for 4 hrs and the device explanted with vessel repair if possible. Activated clotting times (ACT) and plasma free hemoglobin levels were monitored. Necropsy was performed to evaluate for device related complications.

Results: Successful insertion occurred in all animals. Mean RCCA diameter was 3.5 mm (smallest 3.1 mm). Repair of the RCCA in both direct insertion pigs was not possible due to vessel damage, but was successful in animals receiving chimney grafts. Significant bleeding occurred in 1 pig due to inability to achieve graft hemostasis around the sheath. No damage was noted in the RCCA of those animals receiving chimney grafts. There was no evidence of hemolysis. Renal emboli were noted in 3 animals. No cerebral, cardiac or splenic infarcts were noted. There was no aortic valve, mitral valve or left ventricular endomyocardial damage.

Conclusions: Less invasive mechanisms for circulatory support are needed in the pediatric population. Limitations for placement are primarily related to vessel size. This study demonstrated that successful placement of the Impella Pediatric catheter can be safely accomplished in RCCAs as small as 3.1 mm with preservation of the RCCA following device explant.

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The Impella CP and TandemHeart Percutaneous Circulatory Support Devices Show Different Unloading Profiles in a Porcine Model of Acute Myocardial Ischemia

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Background: Percutaneous circulatory support devices are being used to support the left ventricle in cases of acute hemodynamic collapse. The present study investigated the effect of left atrial to femoral artery bypass (TandemHeart (TH)) and left ventricle to ascending aorta (Impella (CP)) on stroke volume (SV), end diastolic volume (EDV), end systolic pressure (ESP), and cardiac energetics including stroke work (SW) and pressure-volume area (PVA) in a porcine model of acute myocardial infarction (AMI) model.

Methods: In large male pigs (avg wt= 74kg), an AMI was created by occluding the left circumflex artery for two hours followed by 30 minutes of reperfusion. Following reperfusion, pressure volume (PV) loops were recorded as Baseline measurements. Then, both the Impella and the TH were implanted and alternatively activated. PV loops were recorded both immediately before and during